NASA-CR-200887

FINAL
7N-90-CR
OCIT
44130

Final Technical Report on NASA NAGW 2122

1 January 1990 - 31 December 1995

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Research in 1990 and 1991 concentrated on the theory of current sheets (tangential discontinuities) that arise spontaneously in magnetic fields as they relax to static equilibrium. We invented the formal "optical analogy" for the purpose of demonstrating the origin of the discontinuities. In 1983 we had suggested that small bursts of rapid reconnection (nanoflares) across the spontaneous discontinuities are the principal heat source for the X-ray corona of the Sun. Recent studies (by other groups) of the emission spectrum show that the coronal temperature varies rapidly with time on small (unresolved) scales, as one would expect for such a sporadic heat source.

It would appear, then, that the slow continuous intermixing of the magnetic footpoints of the bipolar magnetic fields in the photosphere is the energy input responsible for the X-ray emission of the Sun. The magnetic free energy originating in this way is converted to heat via the discontinuities. By inference, we conclude that this is the basis for the X-ray emission of all solitary late main sequence stars. The theory of spontaneous discontinuities and its application to stellar coronae, galactic halos, and the terrestrial magnetosphere is summarized in the monograph Spontaneous Current Sheets in Magnetic Fields, Oxford University Press, New York, 1994.

In 1991 we noted the buoyancy of vortices in a compressible fluid (Parker, 1991) and we showed that hydrodynamic vortices in a stratified atmosphere have a number of remarkable properties, among them the attraction of nearby vertical flux bundles to a down draft vortex ring (Parker, 1992a). The attraction is reminiscent of the clustering of magnetic fields to form sunspots. The work on the generally unexplored theory of vortices in stratified atmospheres has been carried on since by Dr. Steve Arendt who did his Ph.D. thesis research with me (Arendt, 1992).

Research in 1992 and 1993 was directed to problems with the theory of the origin (dynamo) of the magnetic field of the Sun and the Galaxy. The accepted idea is that the magnetic field originates in an $\alpha\omega$-dynamo in both cases, as we suggested in 1955 and in 1971, respectively. However, it is now apparent that the strong mean fields suppress the turbulent diffusion on both cases. But that diffusion, and the associated irreversibility, are an essential part of the theory of the $\alpha\omega$-dynamo. We suggested (Parker, 1992b) that the rapid inflation of lobes of the unstable galactic magnetic field by the continuing production of cosmic rays in the gaseous disk of the Galaxy provides the galactic halo. We conjectured that rapid reconnection between the magnetic fields of adjacent lobes provides the necessary α-effect and irreversibility for the galactic dynamo. We suggested for the Sun that the dynamo is in the form of a surface wave at the bottom "surface" of the convective zone, and that the intensely fibril state of the solar magnetic field leads to rapid reconnection, i.e. the necessary irreversibility, where non-parallel fibril fields meet (Parker, 1993). If remains to be shown to what degree these conjectures really are sufficient to explain quantitatively the solar, stellar, and galactic dynamos.

It should be noted that the $\alpha\omega$-dynamo in the metal core of Earth avoids the theoretical difficulty by being of such small size that ordinary molecular resistivity is sufficient.

Research in 1994 picked up on the evidence (from the work by other groups on the dynamics of flux bundles floating up from the bottom of the convective some to the visible surface) that the azimuthal magnetic field at the bottom of the convective zone is composed of separate flux bundles with field intensities in the range $0.5 - 1.0 \times 10^5$ gauss. We show there is no way that a dynamo can sustain fields of such enormous strength. However, we pointed out that the buoyant rise through the convective zone to the visible surface leads to barometric conditions within the Ω-loop of each risen flux bundle that evacuates the lower ends of the Ω-loop, thereby intensifying the azimuthal portion of the field remaining at the bottom of the convective zone between active Ω-loops (Parker, 1994). The limiting field strength for this effect is estimated at $1.5 - 2 \times 10^5$ gauss, so it may easily account for the inferred $0.5 - 1.0 \times 10^5$ gauss. At the same time we recognized that the sequential rise of Ω-loops to the surface provides a coherent updraft from the bottom to the top of the convective zone locally enhancing the upward convective transport of heat. We suggest that this may be the basis for the increased brightness of the Sun during years of maximum activity (Parker, 1995) along with other variations in the internal circulation (Arendt, 1992).

In 1994 and 1995, Nicholas Boruta carried out calculations of the solar dynamo, from which he was able to show that there can be no dipole magnetic field in excess of about 30 gauss buried in the radiative core of the Sun (Boruta, 1996). This was his Ph.D. thesis, and the importance of the result may be seen from the speculations of $10^6 - 10^7$ gauss to be found in the literature on the suppressed neutrino emission from the Sun.

In 1994 and 1995 we put together a review paper on the theory of magnetospheric physics (Parker, 1996), to appear in the Journal of Geophysical Research. It emphasizes that Newton's equations and Maxwell's equations applied to tenuous plasmas in large-scale magnetic fields provide dynamical partial differential field equations in terms of the bulk plasma velocity $\mathbf{v}$ and the magnetic field $\mathbf{B}$, and those field equations have the familiar form of magnetohydrodynamics. We provided examples of the direct solution of these equations. This is in contrast with the common practice of working with the electric field $\mathbf{E}$ and current density $\mathbf{j}$, which provides global integro-differential equations that are unworkable, even if formally correct. The essential point is that the standard practice of proceeding from declarations about current paths and analog electric circuits, rather than deductions from field equations, yields results that are contrary to those obtained from Newton's equations and Maxwell's equations. The bottom line is that magnetospheric physics should proceed with $\mathbf{B}$ and $\mathbf{v}$ and the associated partial differential field equations if we are to make scientific progress in understandings the magnetosphere.

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April, 1996

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